Pertussis (Whooping Cough)

Section 1

ABOUT THE DISEASE

A. Etiologic Agent

Pertussis is caused by *Bordetella pertussis*, a fastidious, gram-negative, pleomorphic bacillus.

B. Clinical Description

Presentation

- Classically, pertussis begins with the gradual onset of mild upper respiratory tract symptoms, such as coryza (runny nose), sneezing, low-grade fever, and a mild cough (**catarrhal stage**, lasting 1–2 weeks).
- This can progress to severe paroxysms (fits) of cough (**paroxysmal stage**, lasting 2–6 weeks), apparently due to the difficulty of expelling thick mucus from the tracheobronchial tree. At the end of the paroxysm, a long inspiratory effort may be accompanied by a characteristic respiratory whoop, which may be followed by vomiting. Paroxysms tend to occur more frequently at night. Although this kind of cough can be exhausting and frightening, individuals may appear well between bouts of coughing.
- Paroxysms, if present, gradually decrease in frequency and intensity, and other symptoms also wane gradually (**convalescent stage**, lasting weeks to months). During the recovery period, superimposed viral respiratory infections can trigger a recurrence of paroxysms.

The clinical presentation of pertussis varies with age, and diagnosis can be challenging. Disease in infants younger than six months can be atypical with a short catarrhal stage, followed by gagging, gasping, bradycardia (slow heart beat), or apnea (67% have these abnormal pauses in breathing) as prominent early manifestations; absence of whoop; and prolonged convalescence. More than two-thirds of infants with pertussis are hospitalized. Sudden unexpected death can be caused by pertussis in infants. The case fatality rate is approximately 1% in infants younger than two months old.

Older children and adults can present with the classic symptoms of pertussis or with an atypical presentation. Among immunized individuals, particularly adolescents and adults, prolonged cough may be the only manifestation of pertussis. The duration of classic pertussis is six to ten weeks. Approximately half of adolescents with pertussis cough for ten weeks or longer. Even though the disease may be milder in older persons, those who are infected may transmit the disease to other susceptible persons, including unimmunized or incompletely immunized infants. Older persons are often found to have the first case in a household with multiple pertussis cases, and are often the source of infection for children.

Complications

Complications among infants include pneumonia (23%) and pulmonary hypertension, as well as complications related to severe coughing spells, such as subdural bleeding, conjunctival bleeding, and hernia; and severe coughing spells leading to hypoxia and complications such as seizures (2%), encephalopathy (less than 0.5%), apnea and death. Complications among adolescents and adults include syncope, weight loss, sleep disturbances, incontinence, rib fractures, and pneumonia; among adults, complications increase with age.

Pathogenesis

Pertussis is primarily a toxin-mediated disease. The bacteria attach to the cilia of the respiratory epithelial cells, produce toxins that paralyze the cilia, and cause inflammation of the respiratory tract, which interferes with the clearing of pulmonary secretions.

Differential Diagnosis

Healthcare providers should include pertussis in their differential diagnosis for patients in all age groups who present with a prolonged cough illness. The diagnosis of pertussis is further complicated by the need to use diagnostic tests based on the age of the patient and the duration of symptoms, as described later in this chapter. Please refer to Section 2B for guidance on diagnostic tests. The differential diagnosis for respiratory illness often includes infections due to mycoplasma, chlamydia, respiratory syncytial virus (RSV), adenovirus, influenza and other *Bordetella* species (e.g., *B. parapertussis, B. bronchiseptica* (the cause of kennel cough in dogs) and *B. holmseii*). For more about the other Bordetella species see page 15, "Other Species of Bordetella."

Despite increasing awareness and recognition of pertussis as a disease that affects adolescents and adults, pertussis is overlooked in the differential diagnosis of cough illness in this population. Also, adolescents and adults often do not seek medical care until several weeks after the onset of their illness. Therefore, in addition to the agents listed above, the differential diagnosis in older age groups may include other causes of chronic cough, such as allergy, asthma, bronchospasm, gastro-esophageal reflux disease, post viral bronchospasm, sinusitis, and chronic lung disease.

Immunity

Evidence suggests that immunity to *B. pertussis* following vaccination wanes over time. Immunity following natural disease also wanes over a period of time, and exposure to the organism with asymptomatic or mildly symptomatic infection may be needed to maintain effective protection.

C. Vectors and Reservoirs

Humans are the only host.

D. Modes of Transmission

Pertussis is transmitted from person to person by direct or droplet contact with nasopharyngeal secretions of an infected person.

E. Incubation Period

The incubation period is usually 7–10 days, with a range of 5–21 days, and rarely may be as long as 42 days.

F. Period of Communicability or Infectious Period

If not on antibiotics: From two weeks before to three weeks after cough onset. Infants (<1 year) can remain infectious for longer periods (up to 42 days from cough onset) if untreated. **If on antibiotics**: From two weeks before cough onset through the fifth day of appropriate antibiotic treatment.

The secondary attack rate for susceptible household contacts is approximately 80%. Secondary attack rates have been demonstrated to be high even when household contacts are up-to-date with immunizations.

Determining the infectious period: To determine a pertussis case's infectious period, it is helpful to have a calendar. The critical piece of information is the day the case began coughing, which is considered day zero. This information is usually obtained during follow-up with the healthcare provider regarding the patient's course of illness, as well as from the patient.

In the example below, the cough began on January 15th.

January

Su	Mo	Tu	We	Th	Fr	Sa
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	(15)	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

February

Su	Mo	Tu	We	Th	Fr	Sa
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28			

To determine the infectious period:

- Count back 2 weeks (14 days) from the cough onset. This would be January 1st.
- From the cough onset, count forward 3 weeks (21 days). This would be February 5th.

Therefore, the infectious period is from January 1st through February 5th. However, if the individual received appropriate antibiotics within that time period, the infectious period would end after the first five days of full adherence to a recommended course of antibiotic.

G. Epidemiology

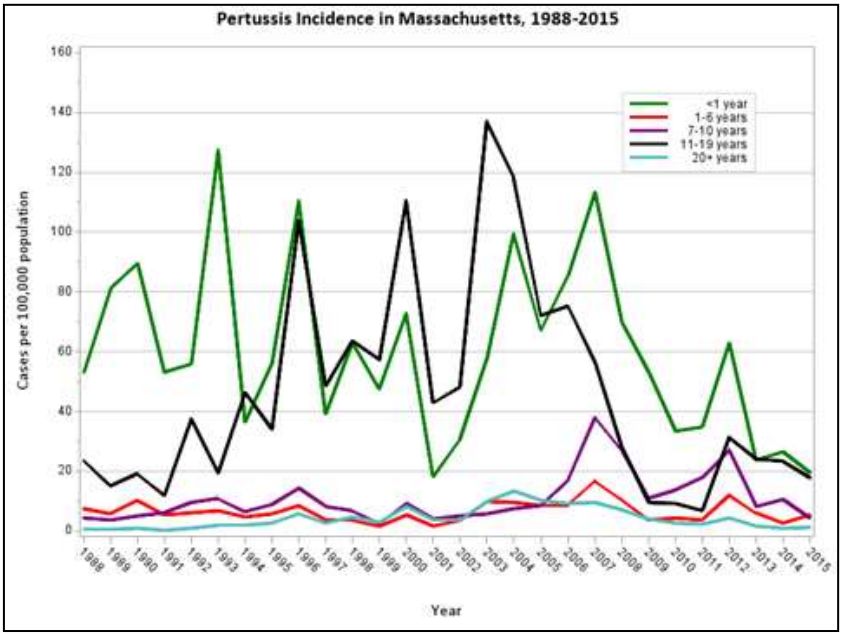
Bordetella pertussis is the most poorly controlled bacterial vaccine-preventable disease in the U.S., with peaks in disease occurring every 3-5 years. Although routine childhood vaccination has resulted in substantial reductions in disease, the number of reported pertussis cases has been steadily increasing since the 1980s. Notable peaks in disease occurred nationally in 2004 (25,827 cases, 27 deaths), 2010 (27,550 cases, 27 deaths), and most recently in 2012 when more than 48,000 cases and 18 deaths were reported (including one pediatric death in Massachusetts), the largest number of cases in the U.S. since 1959. Furthermore, the epidemiologic features of pertussis have changed in recent years with an increasing burden of disease among fully-vaccinated children and adolescents.

Pertussis occurs worldwide. It is endemic, with peaks of incidence occurring every 2–5 years. Pertussis exhibits no distinct seasonality in the U.S. as a whole, although in Massachusetts, the months of greatest incidence are October–December. Pertussis is highly infectious, with secondary attack rates of 80% among susceptible household contacts. A carrier state has been identified, but it is infrequent and transient. It has been demonstrated to result in transmission in families, but its importance in maintaining *B. pertussis* in the community is unknown.

In the pre-vaccine era, pertussis was a common childhood disease and a major cause of child and infant mortality in the United States. Routine childhood vaccination led to a reduction in disease incidence from

an average of 150 reported cases per 100,000 persons between 1922 and 1940, to 0.5 cases per 100,000 persons in 1976. The incidence of reported pertussis began increasing in the 1980s, however, and significant peaks in disease have been observed in recent years. In 2012, 48,277 cases were reported nationwide, exceeding levels observed since 1955. Reported pertussis cases decreased during 2013 to 28,639; however, levels remain significantly increased compared to those observed during the 1990s and early 2000s. Multiple factors have likely contributed to the increase, including heightened provider and public awareness, improved diagnostic testing, waning immunity from acellular pertussis vaccines, and possibly genetic changes within the pertussis bacterium.

The incidence of pertussis remains highest among young infants. In 2013, all pertussis-related deaths (n = 13) reported to CDC were among infants less than 6 months of age, who were too young to have received three doses of DTaP vaccine. This vulnerability of newborns has resulted in recommendations for a dose of Tdap during every pregnancy, and for "cocooning" (vaccination of the family and other close contacts of newborns, to protect the newborn).



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In Massachusetts, and nationally, pertussis is cyclical. The highest incidence tends to be among infants under the age of one, followed by adolescents.

H. Vaccine

Vaccine to prevent pertussis is routinely recommended for children, adolescents and adults. Tdap is recommended for pregnant women with each pregnancy. See the annually-updated ACIP recommendations at http://www.cdc.gov/vaccines/schedules/hcp/index.html.

I. Bioterrorist Potential

This pathogen is not considered to be of risk for use in bioterrorism.

Section 2

REPORTING CRITERIA AND LABORATORY TESTING

A. What to Report to the Massachusetts Department of Public Health (MDPH)

- Laboratory evidence of *B. pertussis* infection by one of the following:
    - Isolation (culture) of *B. pertussis* from a clinical specimen;
    - A positive polymerase chain reaction (PCR) for *B. pertussis* nucleic acid; or
    - A positive pertussis serology performed at the Massachusetts State Public Health Laboratory (MA SPHL).
- Cough illness of any duration in a contact of a laboratory-confirmed case of pertussis

Currently, unless the test is performed at the MA SPHL, pertussis serology results are not valid for case confirmation. The MDPH does not consider a patient with a positive serology result from another laboratory to be laboratory-confirmed. Please see Section 2B for information about what kind of confirmatory testing (if any) is appropriate for a patient with a positive pertussis serology at a laboratory other than MA SPHL.

B. Laboratory Testing Services Available

There are three types of diagnostic tests for pertussis acceptable for public health purposes:

- Culture: Available at the MA SPHL and at some commercial and hospital laboratories.
- PCR: Available at commercial and hospital laboratories.
- Serology: Only serologic assays performed at the MA SPHL are acceptable for laboratory confirmation. *Note: Serology results from commercial and hospital laboratories are not considered interpretable by the MDPH or the Centers for Disease Control and Prevention (CDC).*

Culture

A positive culture for *B. pertussis* in a person with cough illness of any duration confirms the diagnosis of pertussis. However, although bacterial culture is specific for the diagnosis, it is relatively insensitive. Fastidious growth requirements make *B. pertussis* difficult to isolate. Isolation of the organism from a nasopharyngeal (NP) swab is most successful during the catarrhal stage (i.e., first 1–2 weeks). Antibiotics decrease the likelihood of recovering the organism; however, patients treated with antibiotics should still be cultured. Pertussis is slow growing and may take up to two weeks to grow.

PCR

PCR testing of nasopharyngeal (NP) swabs can be a rapid, sensitive, and specific method for diagnosing pertussis. It is now the most commonly used laboratory method for detection of *B. pertussis* because of its improved sensitivity and more rapid turnaround time. However, the high sensitivity of the test means false positive results may be obtained. Therefore, obtaining culture confirmation for at least one suspected case is recommended any time there is suspicion of a pertussis outbreak. PCR is most reliable within the first three weeks after onset of cough and before the initiation of antibiotic therapy. However, treatment should not be postponed for testing. Beyond this period, false negative results become more likely, though PCR can detect the organism's nucleic acid after antibiotic administration and for up to four or more weeks after onset of cough.

Serology

Serology (performed at the MA SPHL), a single-serum assay for IgG to pertussis toxin, is most sensitive 2–8 weeks after onset of cough. Serologic testing has not been validated in children <11 years of age; blood or serum obtained from children <11 years of age will not be accepted for serologic assay. Failure to provide patient date of birth may result in delay in specimen testing. The results of this assay should not be used as presumptive evidence of immunity to pertussis.

Serologic results on patients ≥11 years of age who have received a pertussis-containing vaccine (Tdap) within the past 3 years are not interpretable. Antibodies in these individuals may be the result of vaccination and/or recent infection. For patients under 11 years and those ≥11 with recent doses of Tdap, consider submission of an NP swab for pertussis PCR and culture, if within the appropriate time interval relative to cough onset. Pertussis serology results from laboratories other than the MA SPHL are not accepted as diagnostic for pertussis by the MDPH or the CDC.

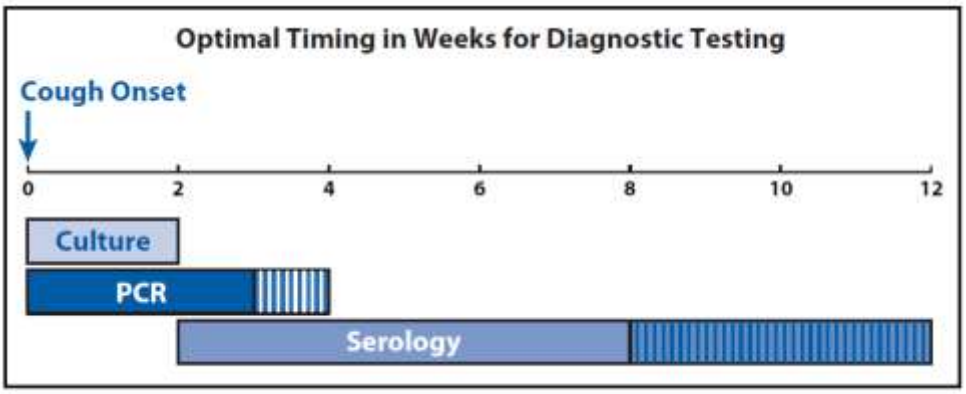
Diagnostic Test Selection

Culture and serologic testing are available at no charge at the MA SPHL. PCR is not currently available at the MA SPHL, but it is widely available at commercial and hospital labs. The appropriate pertussis diagnostic test and specimen type is based on patient age and cough duration, as described in the table below. The reliability of each test depends on age and stage of disease.

Diagnostic Test Recommendations for Testing for Pertussis

Time Since Cough Onset	Patients <11 Years of Age	Patients ≥11 Years of Age
<14 days	NP swab for culture and PCR	NP swab for culture and PCR
14 – 28 days	NP swab for culture and PCR	Serology at MA SPHL[1]-OR serology at MA SPHL, **and** consider NP swab for culture and PCR
29 – 56 days	NP swab for culture and PCR	Serology at MA SPHL

[1] Serologic results for patients ≥11 years of age who have received a pertussis-containing vaccine (TdaP) within the past 3 years are not interpretable. Detected antibodies in these individuals may be the result of either past vaccination and/or recent infection. Instead, consider submission of an NP swab for pertussis and culture testing if within the appropriate time interval relative to cough onset.



Areas that are textured represent timing that is not optimal but may be considered. CDC graphic.

Diagnostic Specimen Submission

Kits for pertussis culture can be ordered from the MA SPHL at (617) 983-6601. Because pertussis test kits have a short shelf life (two months), only the quantity to be used immediately should be ordered. All specimens must be accompanied by a fully completed MA SPHL *Specimen Submission Form* (found on the MDPH website at http://www.mass.gov/eohhs/docs/dph/laboratory-sciences/general-submission-form.pdf). Instructions for specimen collection are included in the kits. For serologic testing, 1–2 mL of serum or 5–10 mL of whole blood collected in a red top or serum separator tube should be submitted (serum is preferable to whole blood). PCR results are usually available within a few business days of specimen receipt at a hospital/commercial lab; culture results, usually within two weeks; and serology in approximately 1–2 weeks.

Section 3

REPORTING RESPONSIBILITIES AND CASE INVESTIGATION

A. Purpose of Surveillance and Reporting

- To identify sources of infection, sites of transmission, and additional cases.
- To identify exposed persons, to assure timely administration of antimicrobial prophylaxis, and to prevent further spread of infection.
- To monitor the effectiveness of outbreak control strategies.
- To monitor the effectiveness of the adolescent and adult Tdap vaccines.

B. Laboratory and Healthcare Provider Reporting Requirements

Pertussis is reportable to the local board of health (LBOH). The MDPH requests that healthcare providers immediately report to the LBOH in the community where the case is diagnosed, all confirmed or suspect cases of pertussis, as defined by the reporting criteria in Section 2A.

Any cluster of pertussis should be reported immediately to the LBOH and to MDPH.

Laboratories performing examinations on any specimens derived from Massachusetts residents that yield evidence of pertussis infection shall report such evidence of infection directly to the MDPH within 24 hours.

C. Local Board of Health (LBOH) Reporting and Follow-Up Responsibilities

Reporting Requirements

MDPH regulations *(105 CMR 300.000)* stipulate that pertussis is reportable to the LBOH and that each LBOH must report any case of pertussis or suspect case of pertussis, as defined by the reporting criteria in Section 2A. Cases should be reported to the MDPH Bureau of Infectious Disease and Laboratory Sciences, Office of Integrated Surveillance and Informatics Services (ISIS) via MAVEN. Refer to the List of Diseases Reportable to Local Boards of Health for information on prioritization and timeliness requirements of reporting and case investigation http://www.mass.gov/eohhs/docs/dph/cdc/reporting/rprtbldiseases-lboh.pdf

Case Investigation

It is the responsibility of the LBOH to complete all questions in each of the question packages by interviewing the case and others who may be able to provide information. Much of the information required can be obtained from the health care provider or from the medical record.

Calling the provider

If the case was hospitalized (i.e. reporting facility is a hospital), call infection control at the named hospital. A list of infection preventionists can be found in the help section of MAVEN. If the case was seen at a clinician's office, ask to speak to a nurse working with the ordering provider.

Calling the case or parent/guardian of the case

Before calling the case, review the disease fact sheet by clicking on the Help Button located in MAVEN and/or the disease chapter in the Guide to Surveillance, Reporting and Control. The call may take a few minutes, so in order to maximize the chance of getting the information needed, it might be good to note the potential length of the call with your contact, and offer the opportunity to call back when it is more convenient. Asking questions about how the case or child is feeling may get the case or parent talking. If you are unable to answer a question they have, don't hesitate to call the Division of Epidemiology and Immunization at 617-983-6800 for assistance, and call the case back with the answer later. People are often more than willing to talk about their illness, and they may be very happy to speak with someone who can answer their questions.

Detailed guidelines on case investigation and disease control are provided in Section 4.

Using MAVEN

Administrative Question Package

Monitor your "Online LBOH Notification for Routine Diseases" workflow in MAVEN for any new cases of pertussis. Once a new event appears in this workflow, open the Administrative Question Package (QP) and under the "Local Health and Investigation" section, answer the first question "**Step 1** - LBOH acknowledged" by selecting "Yes". The "LBOH acknowledged date" will then auto populate to the current day. Completing this first step will move the event out of this workflow and into your "Online LBOH notified but Case Report Forms (CRF) are pending" workflow. Note the date you started your investigation by answering "**Step 2** – Investigation started" as "Yes" and then note the date where shown. Record your name, agency, and phone numbers where shown in "**Step 3** - LBOH/Agency Investigator."

Demographic Question Package

Record all demographic and employment information. It is particularly important to complete the Race/Ethnicity, Place of birth (country), and Occupation questions.

Clinical Question Package

Complete the "Diagnosis/Clinical Information" section, providing the diagnosis date, the date of symptom onset, and other medical information. For case classification purposes, it is particularly important that Cough/Cough Onset Date, Paroxysmal Cough/ Paroxysmal Cough Onset Date, Post-tussive vomiting, whoop, and apnea questions are answered. Please indicate whether or not the patient was hospitalized and, if so, provide the hospital name and admission and discharge dates for each hospitalization.

Vaccine and IG Information Question Package

Enter at least vaccine type and date for any documented doses of pertussis-containing vaccine (e.g., DTaP, Tdap). If the case has no documentation of pertussis-containing vaccines or does not know his or her history, "Vaccination history unknown" should be selected. If the case is known to be unvaccinated, "No vaccine administered" should be selected and an answer to the question "Reason inadequate doses (or no booster) given:" should be entered.

Risk/Exposure/Control & Prevention Question Package

Accurately record all risk questions included in the question package. For the question "Where did this case acquire this illness?" select the most appropriate transmission setting or mark the answer as "Unknown" if no source can be identified. Please note all information regarding school and childcare attendance and institutional settings.

Completing Your Investigation

1. If you were able to complete a case investigation and follow-up is complete, mark "**Step 4** – Case Report Form Completed" as "Yes" and then choose Local Board of Health (LBOH) –Ready for MDPH review for the Completed by variable.
2. If you have made several attempts to obtain case information but have been unsuccessful (e.g., the case or health care provider does not return your calls or respond to a letter, or the case refuses to divulge information or is too ill to be interviewed), please fill out the question packages with as much information as you have gathered, and then complete "**Step 4** - Case Report Form Completed" as "No" and choose a primary reason why the case investigation was not completed from the choices provided in the primary reason answer variable list.
3. If you are not online for MAVEN you may submit a paper case report form. After completing the form, attach laboratory report(s) and fax or mail (in an envelope marked "Confidential") to ISIS. The confidential fax number is (617) 983-6813. Call ISIS at (617) 983-6801 to obtain a copy of the case report form and to confirm receipt of your fax.

   The mailing address is:

   MDPH, Office of Integrated Surveillance and Informatics Services (ISIS)
   305 South Street, 5th Floor
   Jamaica Plain, MA 02130
   Fax: (617) 983-6813

4. Institution of disease control measures is an integral part of case investigation. It is the responsibility of the LBOH to understand, and if necessary, institute the control guidelines listed in Section 4.

Section 4

CONTROLLING FURTHER SPREAD

A. Isolation and Quarantine Requirements *(105 CMR 300.200)*

Minimum Period of Isolation of Patient

For 21 days from onset of cough, or 5 days after initiation of appropriate antibiotic therapy. The first full day of antibiotics is considered to be Day 1. Neither treatment nor exclusion is required for cases beyond

their infectious period, which lasts 21 days after cough onset. These isolation requirements typically apply to laboratory-confirmed cases of pertussis; however, a suspect case who is being treated for pertussis should refrain from public activities until five days of treatment have been completed.

Minimum Period of Quarantine of Contacts

- If the contact is **symptomatic**, use same restrictions as for cases.
- If the contact is asymptomatic, not a healthcare worker, and exposed within the last 21 days, s/he should receive antibiotic prophylaxis, but no exclusion is generally required.
- Asymptomatic healthcare worker contacts who are receiving post-exposure prophylaxis do not need to be excluded.
- Asymptomatic healthcare workers not receiving antibiotic prophylaxis should be excluded from the workplace for 21 days after last exposure, or if last exposure is unknown, for 21 days after the onset of the last case in the setting.
- In certain situations deemed to be high-risk, the MDPH may require exclusion of asymptomatic contacts not receiving antibiotic prophylaxis and/or other contacts, and/or may extend the exclusion period beyond 21 days up to a maximum of 42 days.

Please note that the quarantine requirements typically apply to contacts of laboratory confirmed cases. This may change during an outbreak. Please refer to the most recent isolation and quarantine requirements on the MDPH website at http://www.mass.gov/eohhs/gov/departments/dph/programs/id/epidemiology/rdiq/.

B. Antibiotics for Treatment and Prophylaxis

Early presumptive treatment within 21 days of cough onset reduces transmission and is a major component of disease control. The spread of pertussis can be limited by decreasing the infectivity of the patient and by protecting close contacts. Clinicians should begin antimicrobial therapy prior to test results if the clinical history is strongly suggestive of pertussis or the patient is at high risk of severe or complicated disease, or will have close contact with those at high risk of developing severe pertussis. In general, a 5-day course of azithromycin is the appropriate first-line choice for treatment and for postexposure prophylaxis (PEP). Initiating treatment >21 days after cough onset is unlikely to be beneficial in older patients, but should be considered for infants <12 months, particularly for those <6 months of age. However, treatment should be initiated in any coughing individual who is culture positive, regardless of the time since cough onset.

Providers should refer to standard resources (e.g., *The Red Book: 2015 Report of the Committee on Infectious Diseases*) for more information about antibiotics for pertussis treatment and prophylaxis. CDC also has information at http://www.cdc.gov/pertussis/clinical/treatment.html. MDPH, like CDC, promotes the judicious use of antibiotics. PEP should be prioritized for those at highest risk of severe or complicated disease, and for those most likely to have close contact with high-risk individuals (e.g., healthcare providers in a NICU).

Infants < six months of age: Antimicrobial agents used for infants younger than 6 months require special consideration due to lack of FDA-approved antimicrobials for this age group and a possible increased risk of infantile hypertrophic pyloric stenosis in infants under one month of age. Consult The Red Book (2015, p. 610) and other resources for clinicians. Initiating treatment >21 days after cough onset is unlikely to be beneficial in older patients, but should be considered for infants <12 months, particularly for those <6 months of age.

Prophylaxis: Initiate antibiotic prophylaxis within 21 days of exposure. The antibiotic doses and schedules for prophylaxis are the same as for treatment. Prophylaxis should be considered within 42 days (6 weeks) of exposure for infants <12 months of age, particularly for those <6 months of age, in consultation with MDPH.

C. Control Measures for the Case

1) Determine if the case is lab confirmed.
    a. When a provider suspects pertussis and treats a patient with antibiotics, the patient should refrain from public activities until five days of treatment have elapsed, even if the case has not been confirmed.
2) Determine cough onset date.
3) Case should be excluded from all public activities for 21 days after cough onset, or until he/she completes five days of appropriate antibiotic therapy.
4) Neither treatment nor exclusion is required for cases beyond their infectious period, which lasts 21 days after cough onset.
5) Evaluate immunization status of case; refer for vaccination if necessary.

Note: In certain situations deemed to be high-risk, MDPH may make additional recommendations regarding control measures (e.g., treatment, prophylaxis, and exclusion.)

D. General Control Measures for Close Contacts

Because there are many causes of cough illness, laboratory confirmation is usually the starting point for a public health investigation and implementation of official control measures, unless an outbreak is occurring.

Early presumptive treatment reduces transmission and is a major component of disease control. The spread of pertussis can be limited by decreasing the infectivity of the patient and by protecting close contacts. Broad-based use of antibiotic prophylaxis is no longer recommended. There are no data to indicate that widespread use of PEP among contacts effectively controls or limits the scope of pertussis outbreaks. Prophylaxis has become much more targeted at those at high risk of developing complications, as well as on those who could potentially transmit disease to high-risk patients. See "Identification of Close Contacts" on page 17. However, if a provider highly suspects pertussis, and is treating the patient, it is reasonable for the rest of the household to also be treated, especially high-risk household contacts, even before the case is confirmed.

1) Determine if the case is lab-confirmed. If so, proceed with the following:
2) Identify the case's dates of **cough onset**, and antibiotic treatment timeframe, to determine the **infectious period** (two weeks before cough onset and three weeks after, or until five days of antibiotic treatment has elapsed).
    a. Patients with chronic cough: It can be challenging to identify a "cough onset" date for a patient with chronic cough. Sometimes patients are able to identify a point at which they noticed a worsening of cough, or a change in the quality of cough. If it is impossible to determine a cough onset, it is reasonable to use the date of medical evaluation as a substitute for cough onset date.
3) Identify all **close contacts** exposed to the case while the case was infectious:

a. All household contacts are usually considered close contacts. See "Identification of Close Contacts" on page 17 for more information.
b. Identify and prioritize **high risk contacts**, and **transmission risk contacts**. See page 17.

4) **Symptomatic close contacts should be treated as suspect cases of pertussis.** Refer symptomatic close contacts for medical evaluation, testing and treatment, and **exclude** from public activities until they have completed appropriate antibiotic treatment, or until 21 days from their onset of cough. Sample letters for this kind of notification are available at MDPH (617) 983-6800.

5) Refer **asymptomatic** close contacts for antimicrobial post-exposure prophylaxis if <21 days since the last exposure to the case while the case was infectious.
   a. **Infants <1 year, particularly those <6 months** who are asymptomatic should be referred for evaluation and consideration of PEP within 42 days of the last exposure, in consultation with MDPH.
   b. Asymptomatic close contacts, in general, do not need to be excluded from public activities.
   c. Asymptomatic contacts should be educated about the signs and symptoms of pertussis and should be advised to seek medical evaluation and testing, should symptoms develop. Sample letters for this kind of notification are available at MDPH (617) 983-6800.

6) Evaluate immunization status of contacts and refer for vaccination if necessary. The latest ACIP recommended schedules are at http://www.cdc.gov/vaccines/schedules/hcp/index.html.

7) Consider the possibility of notification to others who may have been exposed, but were not identified as close contacts. MDPH has sample letters for this kind of notification.

8) See Section E below for special situations: schools, childcare centers, and healthcare settings.

9) Conduct surveillance for cough illness, with referral of suspect cases for medical evaluation, diagnostic testing, and antibiotic prophylaxis, for two incubation periods (42 days).

E. Management of Special Situations: Schools, Childcare Centers, and Healthcare Settings

Special Guidance for Schools (*In addition to the steps listed above, p. 11-12):*

- Work with the school nurse or other school personnel (such as teachers and coaches) to identify close contacts who were exposed to the case while the case was infectious, especially those at increased risk of severe disease, or increased risk of transmission to those at increased risk of severe disease. See "Identification of Close Contacts" on page 17.
- It is helpful to telephone the contacts, or the parents of contacts, especially the symptomatic ones, as well as sending letters home. The school nurse usually makes these calls.
- In general, prophylaxis is **not** usually indicated for an entire classroom where there is one laboratory-confirmed case. In the school setting, prophylaxis should be limited to those defined as close contacts, and surveillance for additional cases of cough illness. However, there may be some rare exceptions to this, such as special needs classrooms where there is a great deal of close contact, or many high-risk students, or small classrooms of very young children.
- Notify teachers or coaches who have a case in their class or on their sports team to refer other coughing children to the nurse's office for evaluation.
- School personnel should keep track of symptomatic close contacts in a line listing of suspect cases. This information will help in deciding whether larger groups need to be prophylaxed.

- Exclusion of unvaccinated or under-vaccinated students is usually not indicated.
- Sample letters are available from MDPH at (617) 983-6800.

Special Guidance for Childcare Centers (*In addition to the steps listed above, p. 11-12):*

The main focus in childcare is preventing the transmission of pertussis to infants, particularly those <6 months of age (as well as other high-risk individuals). Therefore, keep the following in mind:

- Entire classrooms in the childcare setting (including the classroom staff) are usually considered close contacts due to the nature of interaction between children (e.g., less than optimal cough etiquette, hand hygiene, and sharing/mouthing of toys in this age group) and should receive antibiotic prophylaxis, if indicated.
- Because of the age, immunization status and other risk factors of many childcare attendees, most individuals should be referred to their providers, regardless of whether or not they have symptoms.
- If feasible, it is helpful to telephone the contacts/parents, especially the symptomatic ones, as well as sending letters home. The affected institution usually makes these calls.
- Carefully evaluate the situation with regard to staff that may work in several different classrooms throughout the day or week and have contact with the case as well as with infants.
- Keep in mind that treatment should be considered within 42 days (6 weeks) of cough onset in infants <1 year of age, particularly in those <6 months of age. However, there is no need to exclude individuals in these 2 groups if it has been at least 21 days since cough onset (regardless of antibiotic compliance).
- Because of the rare possibility of a 42-day incubation period**,** prophylaxis should be considered for contacts of a case that are infants <1 year of age, particularly those <6 months of age, within 42 days of exposure, in consultation with MDPH.
- Accelerated vaccination schedule for infants and children <7 years of age: For an individual infant or child <7 years of age, circumstances may warrant an accelerated schedule to provide protection as early as possible, such as due to travel, potential loss to follow-up or increased risk of exposure to pertussis. An accelerated schedule can be started as soon as the infant is six weeks of age, with the second and third doses given no earlier than four weeks after each preceding dose. The fourth dose should not be given before the infant is 12 months of age and should be separated from the third dose by at least six months. The fifth (booster) dose should not be given before the child is four years of age. When considering an accelerated schedule, providers should also weigh the impact of timing of other recommended vaccines and well-child visits.
- The facility should keep track of symptomatic close contacts in a line listing of suspect cases. This information will help in deciding whether larger groups need to be prophylaxed.
- Sample letters are available from MDPH at (617) 983-6800.

Special Guidance for Healthcare Settings *(In addition to the steps listed above, p. 11-12):*

Due to the potential for transmission to individuals at high risk of complications from pertussis, exposure criteria and control measures in healthcare settings are more rigorous than in other settings. If there is a high index of suspicion of pertussis in a healthcare worker (regardless of there being an epidemiological link to a confirmed case or not), the individual should receive medical evaluation, appropriate diagnostic testing, and antibiotic treatment. The individual should also be excluded from the workplace through the first five days of appropriate antimicrobial therapy.

1. In an inpatient setting, patients with pertussis and symptomatic contacts should be placed on standard and **droplet precautions** until five days of the full course of antibiotic therapy have been completed.
2. In the outpatient setting, restrict the case and symptomatic close contacts from public activities for the first five days of the full course of antibiotic therapy, as described previously.
3. Keep in mind that treatment should be considered within 42 days (6 weeks) of cough onset in infants <1 year of age, particularly those <6 months of age. However, there is no need to exclude individuals in these 2 groups if it has been at least 21 days since cough onset (regardless of antibiotic compliance).
4. Because of the rare possibility of a 42-day incubation period, prophylaxis should be considered for contacts of a case that are infants <1 year of age, particularly those <6 months of age, within 42 days of exposure, in consultation with MDPH.
5. Waiting rooms: In general, individuals who were in waiting rooms or other care areas at the same time as a pertussis case are not considered close contacts.
6. If the case is a healthcare worker, restrict the case from work and other public activities for the first five days of the full course of antibiotic therapy. If it has been >21 days since the provider's cough onset, isolation is not required.
7. If the case is a healthcare worker, close contacts among other staff and patients, during the healthcare worker's infectious period, will need to be identified and notified, with associated recommendations for treatment and prophylaxis. Pay close attention to those exposed who are at high risk of complications, and who are at increased risk of transmitting pertussis to medically fragile patients.
8. Symptomatic exposed healthcare staff should be restricted from work, pending completion of treatment or 21 days since cough onset, the same as a confirmed case.
9. In outbreaks, when continued transmission of pertussis is evident, multiple rounds of antibiotics would not be recommended. Rather than repeating a course of antibiotics, contacts should be monitored for onset of signs and symptoms of pertussis for 21 days. A daily check-in with Occupational Health may be implemented.
10. *Note: In certain situations deemed to be high-risk, the MDPH may make additional recommendations regarding control measures (e.g., treatment, prophylaxis, and exclusion).*

In healthcare settings, the definition of "close contact" is more rigorous and includes the following:

a. Having face-to-face contact within three feet of the case, without wearing a surgical mask* or other protection of the face and respiratory tract; this includes conducting a medical examination, obtaining a NP culture, suctioning, intubating, performing bronchoscopy, or a similar procedure without wearing a mask.
b. Conducting any procedure that induces coughing of the case, even if farther from the case than three feet, without wearing a surgical mask or other protection of the face and respiratory tract.
c. Coming into mucosal contact with respiratory, oral, or nasal secretions of the case directly or via fomites.
d. Sharing a room with the case; degree of contact and risk of infection in such situations should be evaluated on a case-by-case basis.
e. Having any other close contact with a case.

Transmission risk: Healthcare providers (e.g., NICU staff) may be at high risk for transmitting pertussis to medically fragile patients. When in doubt concerning close contact to a confirmed case, err on the side of caution. **These staff should be prioritized for PEP.**

** Please note that if a surgical mask was worn by the case and/or the contact during the entire exam, including specimen collection, there is no need for prophylaxis of the contact. However, this does not imply that a healthcare provider who is infectious with pertussis can continue working while masked.*

F. Outbreak Management

When five or more confirmed cases occur during a defined period at a specific location, and these cases appear to be related to each other, an outbreak may be taking place. Consult with an MDPH epidemiologist when this occurs. Pertussis outbreaks can be difficult to identify and manage. Other respiratory pathogens often cause clinical symptoms similar to pertussis, and co-circulation with other pathogens does occur. To respond appropriately (e.g., provide appropriate prophylaxis), it is important to confirm that *B. pertussis* is circulating in the outbreak setting and to determine whether other pathogens are contributing to the outbreak. PCR tests vary in specificity, so obtaining culture confirmation of pertussis for at least one suspected case is recommended any time there is suspicion of a pertussis outbreak.

To reduce the risk of pertussis in new mothers and their very young infants, ACIP recommends that pregnant women receive a dose of Tdap vaccine during each pregnancy. During outbreaks, prevention measures should focus on efforts to improve coverage with Tdap during pregnancy to reduce severe illness and possible death in vulnerable infants.

With increasing incidence and widespread community transmission of pertussis, extensive contact tracing and broad scale use of postexposure antimicrobial prophylaxis (PEP) among contacts may not be an effective use of limited public health resources. While antibiotics may prevent pertussis disease if given prior to symptom onset, there are no data to indicate that widespread use of PEP among contacts effectively controls or limits the scope of pertussis outbreaks. Another important consideration is the overuse of antibiotics; CDC is engaged in actively promoting the judicious use of antibiotics among healthcare providers and parents. Given these considerations, CDC supports targeting PEP to persons at high risk of developing severe pertussis and to persons who will have close contact with those at high risk of developing severe pertussis

Active screening for symptomatic persons with suspected pertussis can be considered during outbreaks in settings such as schools, daycare centers, and hospitals. Active screening for suspected cases potentially reduces exposure to persons with pertussis, encourages timely medical evaluation and treatment of cases, and promotes prompt administration of antibiotics to high risk close contacts.

G. Other Species of Bordetella

Other species of Bordetella *(B. parapertussis, B. holmseii, B. bronchiseptica)* do not call for the same control measures as *B. pertussis*. However, MDPH recommends the following:

- *B. parapertussis* can cause illness similar to whooping cough, but generally milder. Limited data suggest *B. parapertussis* is less susceptible to antibiotics than *B*. *pertussis*, although some studies indicate that erythromycin, azithromycin, clarithromycin, TMP-SMZ, and ciprofloxacin have activity against *B. parapertussis*. Because data on the clinical effectiveness of antibiotic treatment are limited, treatment decisions should be based on clinical judgment, with particular attention towards special populations, including infants, elderly, and immunocompromised persons; treatment may be warranted to prevent severe outcomes and decrease duration of illness. Treatment of the case is usually recommended. If

close contacts of the case are <1 year of age, consider prophylaxis for the exposed young contacts, and for anyone else exposed who is at risk of transmitting the illness to children <1.

- *B. holmseii* cases should be treated with antibiotics as per a case of whooping cough. There are no control measures.
- *B. bronchiseptica* is one pathogen that can be involved in "kennel cough" in dogs, and respiratory illness in rabbits, cats and pigs. It is a rare cause of disease in humans and is more likely to occur in individuals with immune compromise. Transmission directly from animals to humans is possible but has not been well documented. Any dog in a household with a respiratory illness, especially one characterized by a cough, should be seen by a veterinarian for diagnosis and treatment, if indicated, to prevent possible transmission to humans. Any rabbit, cat or pig in the household with respiratory illness should also receive veterinary care for the same reason. When a human case occurs, the patient should be asked to identify if there are any ill animals at home; animals with respiratory illness should be seen by a veterinarian to limit the possibility of transmission. Patients should discuss treatment with their healthcare providers. There are no other control measures.

H. Preventive Measures

Routine childhood vaccination, the Tdap booster dose, Tdap with every pregnancy, and targeted post-exposure antimicrobial prophylaxis are the best preventive measures against pertussis. Good personal hygiene (which consists of proper hand hygiene, disposal of used tissues, not sharing eating utensils, etc.) is also important. Relevant resources are available through the MDPH Division of Epidemiology and Immunization at (617) 983-6800. A Pertussis Public Health Fact Sheet for the general public can be obtained from the MDPH Division of Epidemiology and Immunization or on the MDPH website at www.mass.gov/dph/epi.

ADDITIONAL INFORMATION

Case definitions: The CDC and the MDPH use CDC case definitions to maintain uniform standards for national reporting. For reporting to the MDPH, always use the criteria outlined in Section 2A. *The most up-to-date CDC case definitions are available on the CDC website at https://wwwn.cdc.gov/nndss/case-definitions.html. In addition, MAVEN users can click on the "Help" icon (looks like a Question Mark next to "Enter Case ID" at the top of the screen). Click on the "Case Classification" folder.*

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Identification of Close Contacts

Identification of close contacts is not an exact science. Do your best to identify those who were in very close contact with the case while the case was infectious, where contact with respiratory aerosols is likely. Start with those in close proximity to the case. **Prioritize those at high risk of medical complications, and those at high risk of transmitting pertussis to medically vulnerable populations.**

Household contacts	Almost always considered close contacts. Includes persons who occupy a particular housing unit as their usual residence, or who live there at the time of disease in the case, and other close contacts, including caregivers who come to the house regularly, friends/relatives who visit often, overnight guests, and intimate contacts of the case.
Face-to-face contact	Have had close face-to-face contact (within three feet), regardless of duration, with a case while the case is infectious. It includes sharing the same confined space in close proximity to an infected person for ≥1 hour, e.g., ≥1 hour in a small car. This does not usually include casual contact, like sharing the same classroom, waiting room, office space, or other casual types of interactions, except in some rare circumstances**.** Note: Some sports (e.g., hockey, lacrosse) can involve a lot of face-to-face contact.
Direct contact	Have had direct contact with respiratory, oral, or nasal secretions from an infectious case. Examples include an explosive cough or sneeze in the face; sharing food/eating utensils during a meal; kissing; sharing lip gloss, lipstick, cigarettes, or similar items; or performing medical/dental examination or procedure (e.g., suction, intubation, exam of mouth/throat, or bronchoscopy) without appropriate PPE.
Identification of "High-Risk" Close Contacts – High Priority for Follow Up	
High risk of serious complications from	• Infants <1 year of age (particularly those <6 months of age*); • Immunocompromised individuals;

pertussis and adverse outcomes.	• Individuals with chronic lung disease (including asthma and cystic fibrosis); • Individuals with neuromuscular disorders that prevent or reduce the ability to clear secretions; or • Unimmunized or underimmunized children. *For infants <1 year, particularly those <6 months, consider treatment within 42 days of onset of cough onset, and prophylaxis within 42 days of exposure (in consultation with MDPH).
Identification of "Transmission-Risk" Close Contacts – High Priority for Follow Up	
Transmission-risk contacts: may transmit pertussis to those at high risk for severe disease and adverse outcomes.	• Household members and other close contacts in a household setting where there is a high-risk individual. • Pregnant women in their 3rd trimester (due to concern about transmission to their newborn). • Those attending or working in childcare settings (i.e., same room), if there are infants or a pregnant woman who is in her 3rd trimester or other high-risk individuals in the setting. • Healthcare workers providing direct patient care, particularly to those listed as high-risk (e.g., NICU, obstetrics, labor and delivery, or bone marrow transplant unit).

For more detailed information about close contacts in healthcare settings, see page 14.